国际钼协会与大中华
IMOA and Greater China

钼：发展高端用钢的关键推动者
2018-2019概述

Moly: the key Driver for High End Steels Development
General Overview 2018 – 2019

G. Ronchi - Xian October 17th 2018

全球十大钢铁消费国

Top 10 Steel Using Countries

钼消费总量的80%以上用于钢铁 Over 80% of Mo consumption is for steel

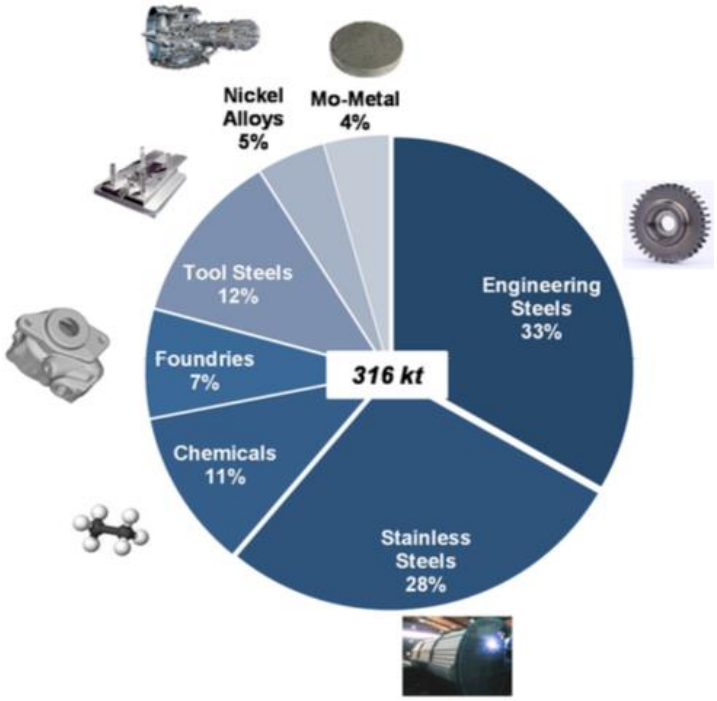
	百万吨 million tonnes			同比增长 y-o-y growth rates, %		
	2015	2016 (f)	2017 (f)	2015	2016 (f)	2017 (f)
China 中国	672.3	665.6	652.3	-5.4	-1.0	-2.0
United States 美国	96.1	95.0	97.8	-10.1	-1.2	3.0
India 印度	80.1	84.4	89.1	5.3	5.4	5.7
Japan 日本	63.0	62.7	63.6	-7.0	-0.4	1.4
South Korea 韩国	55.8	56.4	54.6	0.5	1.0	-3.1
Russia 俄罗斯	39.4	38.0	38.4	-8.3	-3.6	0.9
Germany 德国	39.2	40.0	40.4	-1.2	2.0	1.0
Turkey 土耳其	34.4	36.0	37.5	11.7	4.8	4.2
Mexico 墨西哥	24.2	24.6	25.4	5.8	1.6	3.2
Brazil 巴西	21.3	18.2	18.9	-16.9	-14.4	3.8

Source: Worldsteel October 2016

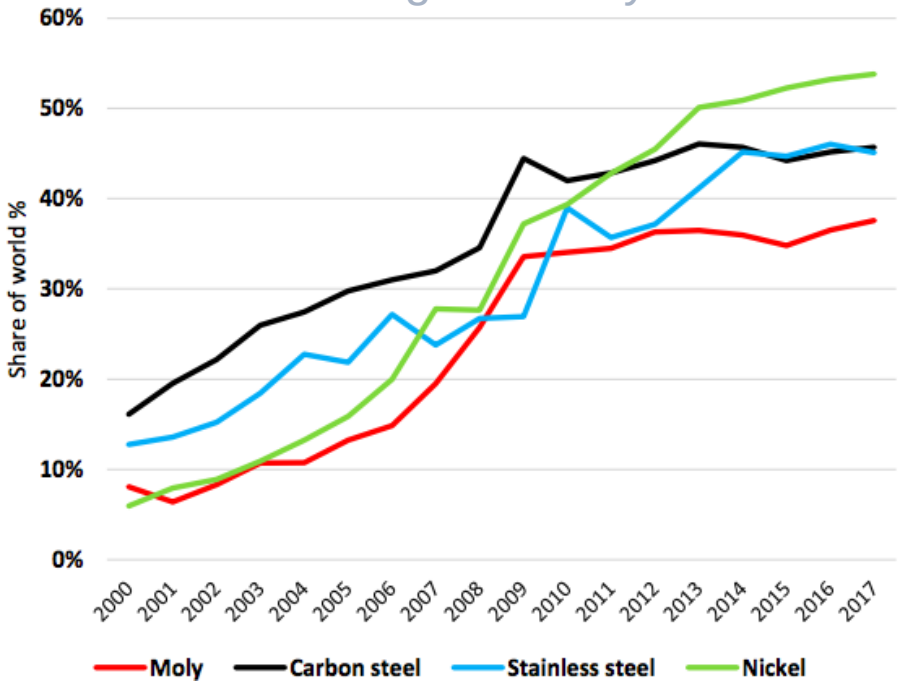
其它9国之和为4.2亿吨，相当于中国总量的63%

The other 9 contires altogether = 420 mill. or 63% of China

钼与钢 Moly and Steel



全球钼消费量中，中国只占很小份额
China's share in global moly use is low



Source: CRU, IMOA , Red Door Research

钼消费总量中，85%以上用于钢铁，其中; 2/3 用于特殊钢，1/3 用于不锈钢

钢铁中的钼消费量 - 2017

Moly in Steel - 2017 consumption matrix (Tons)

27.4万吨钼用于“钢”（镍合金、钼金属和钼化工不包括在内）

274.000 t of Mo used for “Steel” (Excluded Nickel alloys, Mo metal, Chemicals)

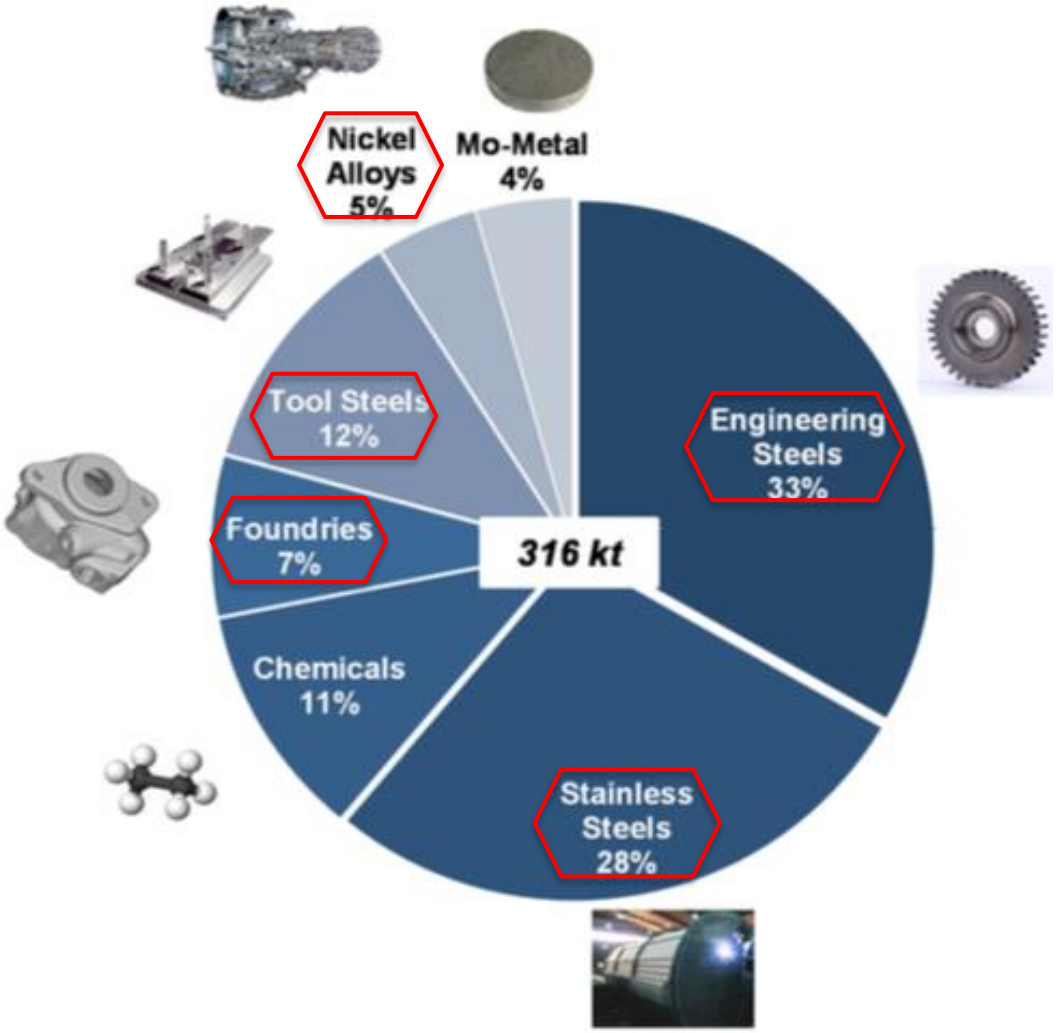
	Eng. Steel		Stslss		ATS/HSS		Foundries (*)		Total	
Europe	23,290	20%	20,810	22%	8,020	21%	5,560	22%	**57,680**	**21%**
Americas	24,250	21%	16,030	17%	6,190	16%	4,650	19%	**51,121**	**19%**
Other Asia	18,350	16%	17,240	18%	6,560	17%	3,770	15%	**45,921**	**17%**
Other World	15,730	14%	12,420	11%	3,910	3%	2,810	2%	34,870	30%
Total Exc China	**81,620**	71%	**66,500**	71%	**24,680**	63%	**16,790**	67%	**189,591**	**69%**
China	34,120	29%	27,800	29%	14,210	37%	8,310	33%	**84,440**	**31%**
Total	**115,740**	100%	**94,300**	100%	**38,890**	100%	**25,100**	100%	**274,031**	**100%**

(*) 85% of castings are steel

Source SMR – End-use of Molybdenum

国际钼协会在中国大陆推广钼应用

IMOA Moly Development in Mainland China



国际钼协会在中国大陆推广钼应用

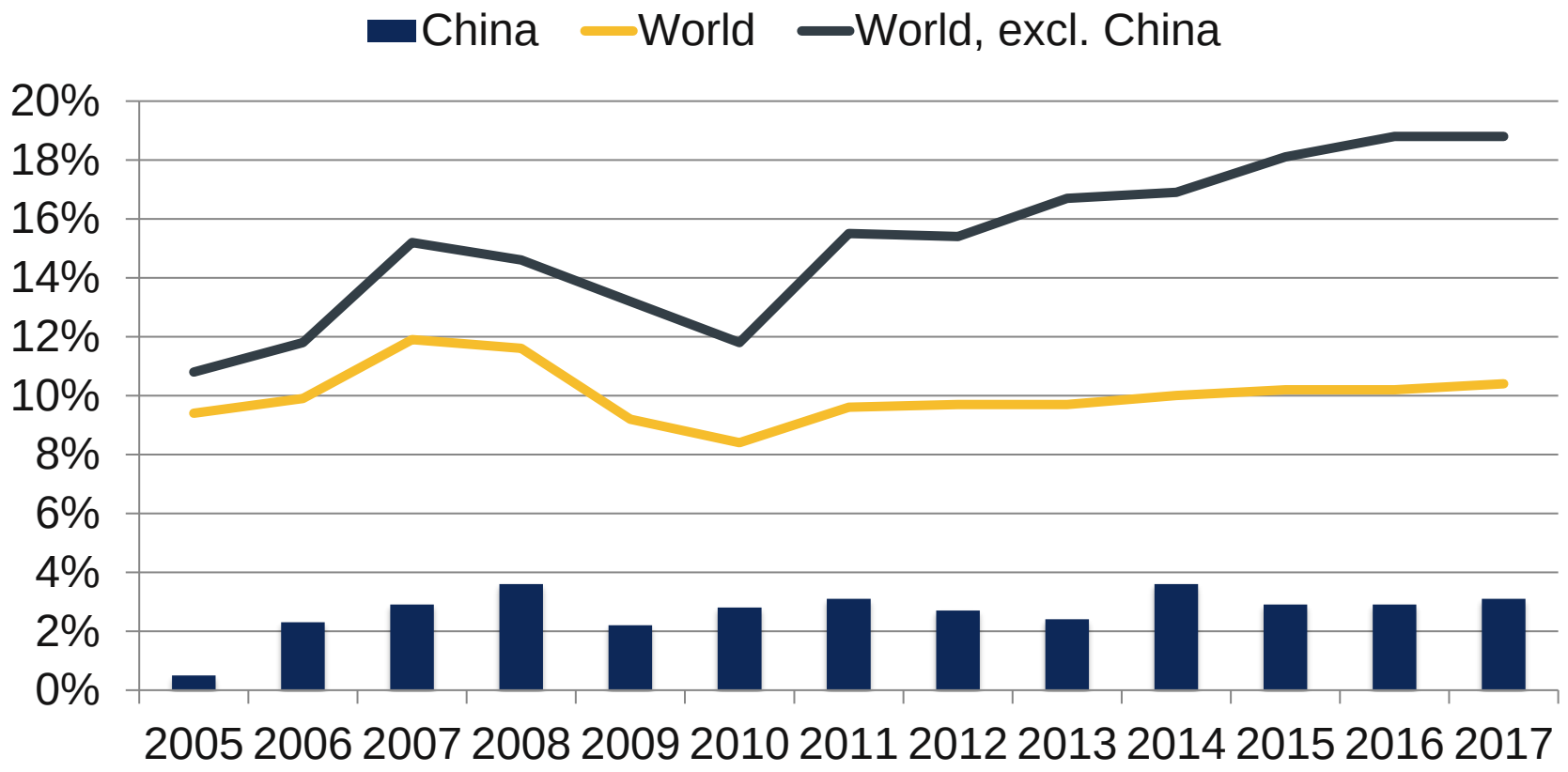
IMOA Moly Development in Mainland China

I. 不锈钢 Stainless Steel

II. 先进钢铁材料 Advanced steel materials

1 含钼不锈钢的市场份额

I. Stainless Steel Market share Mo-grades



Data: ISSF, CSSC, Beijing

I. 不锈钢 Stainless Steel

1) 建筑应用 (ABC)

- 美观，长寿命 Aesthetical longevity

2) 结构部件及设计

Structural components and design

- 强度和刚度 Strength and stiffness

3) 耐蚀性 Corrosion resistance

- 局部腐蚀 Localized corrosion

1) ABC – 建筑领域

Architecture Building Construction

八个城市27个项目　An active list with 27 projects in 8 cities:
上海 (5), 北京 (4), 深圳 (13), 贵阳 (2) , 福州 (1), 武汉 (1), 绍兴 (1)

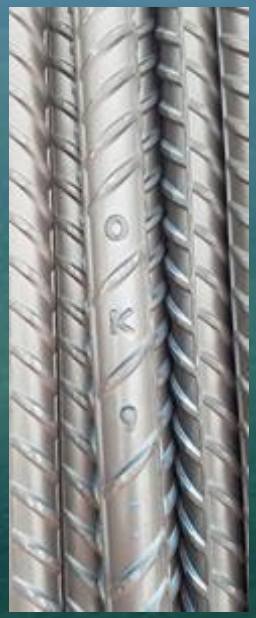
27个项目的不锈钢用量超过2万吨，钼的消费量大约是400吨

The Stainless steel potential for the 27 projects can be estimated in over 20.000 t or 400t of Moly

2) 建筑结构用不锈钢 Structural Stainless Steel

港珠澳大桥 Hong Kong-Zhuhai-Macau (HZMB) Bridge

世界上最长的跨海大桥 (55 kilometers) The world‘s longest sea-crossing bridge

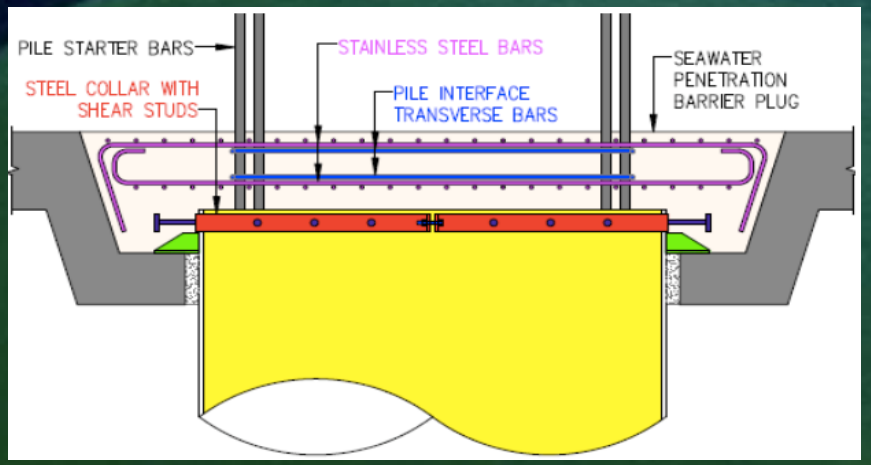


双相钢螺纹钢筋
1.5万吨，钼60吨

Duplex EN 1.4362

15.000 t ; **60 t Mo**

Ribbed Rebar

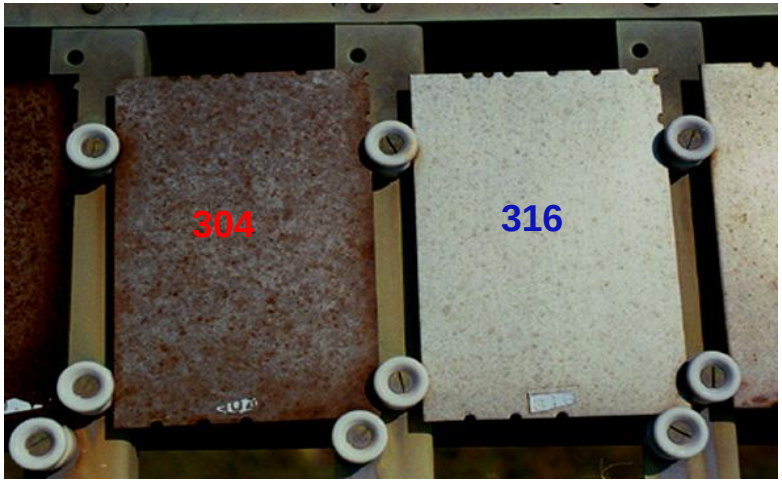


3) 耐腐蚀性 Corrosion Resistance

不锈钢和镍基合金临界点蚀温度（CPT）和临界缝隙腐蚀温度（CCT）

Stainless Steel and Nickel Alloy Ranking by Critical Pitting Temperature (CPT) and Critical Crevice Corrosion Temperature (CCT)

Alloy	%Mo	CPT, °C	CCT, °C	PREN
316	2.2	20	<0	25.3
825	3	30	5	33.6
6%Mo SS	6	75	35	48.4
7%Mo SS	7	>85	50	55.7
625	9	>85	35	51.7
C-276	16	>85	45	67.1

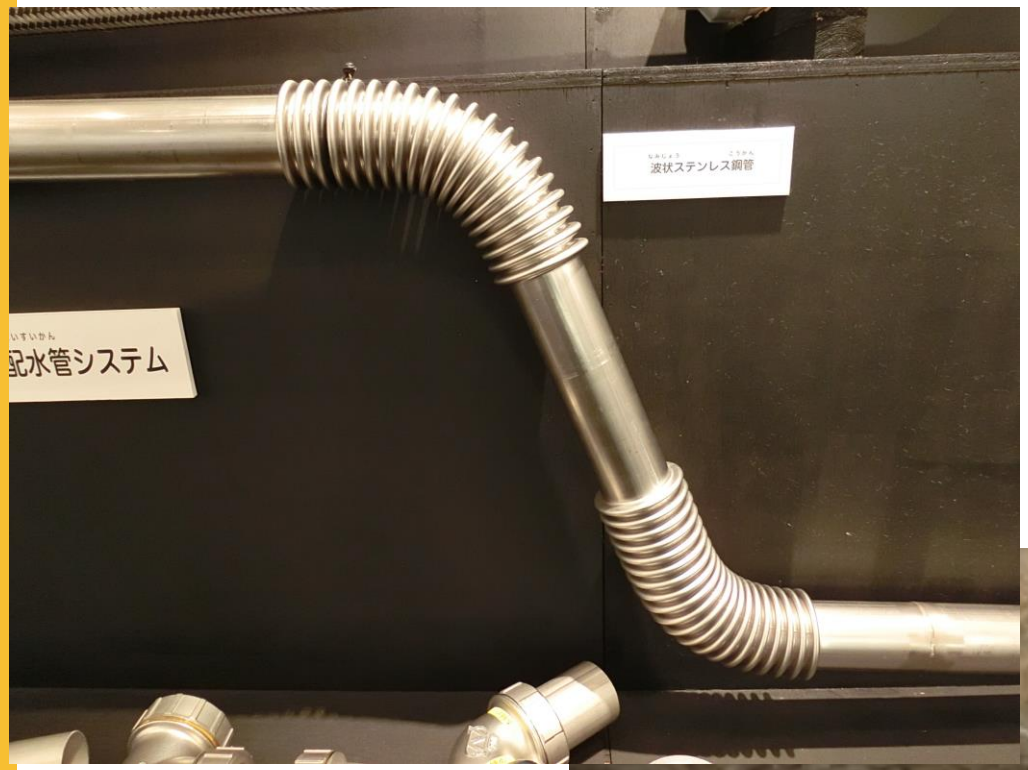


供水管道先进防漏措施

Water Distribution, Advanced leak management

供水管网漏水率高 High leakage rate in service pipe

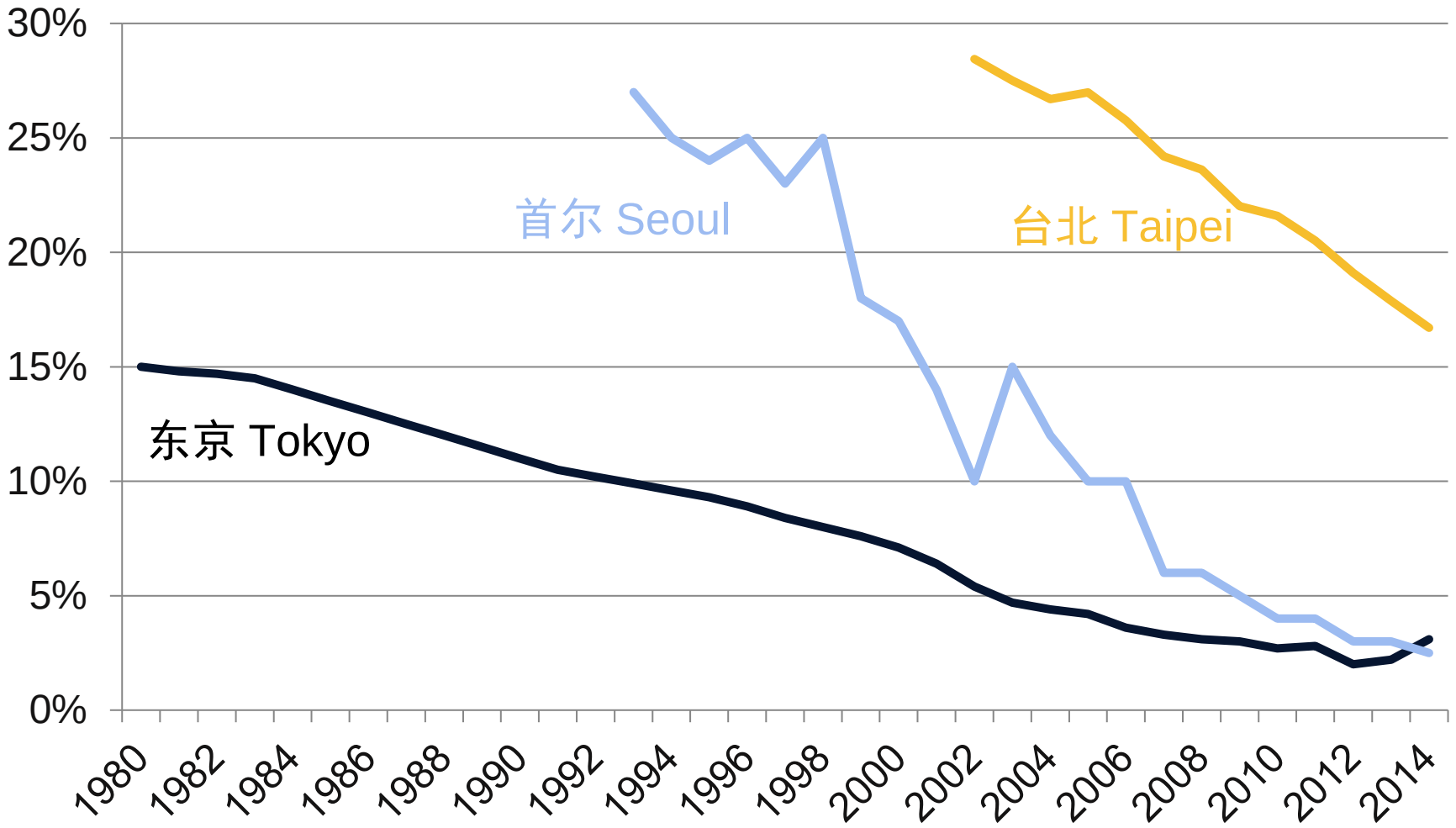
全球漏水率20-35% Worldwide leakage ranks between 20 and 35%



解决方案: 316不锈钢波纹管

Solution: Corrugated 316L SS pipe

漏水率逐年下降 Leakage rates over time



Sources: Tokyo: Tokyo Waterworks Bureau; Seoul: Ministry of environment, Republic of Korea; Taipei: Taipei Water Department; Hong Kong: OECD report

II. 先进钢铁材料 Advanced steel materials

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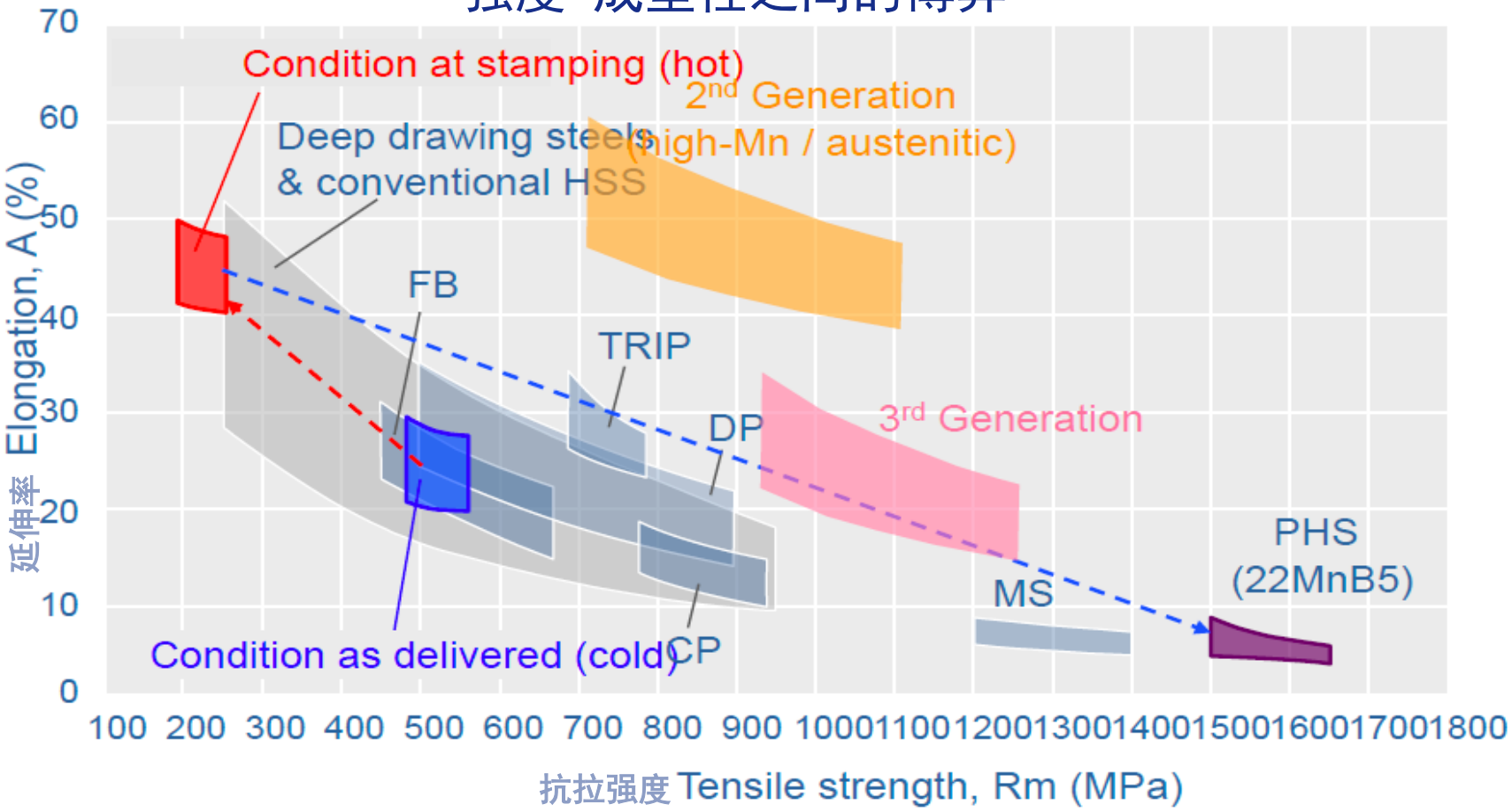
1) 先进结构钢
   Advanced structural steels (AHSS)

2) 工程钢和工具钢
   Engineering and tool steels

3) 铸铁
   Cast iron

II. 先进钢铁材料 Advanced steel materials

强度–成型性之间的博弈

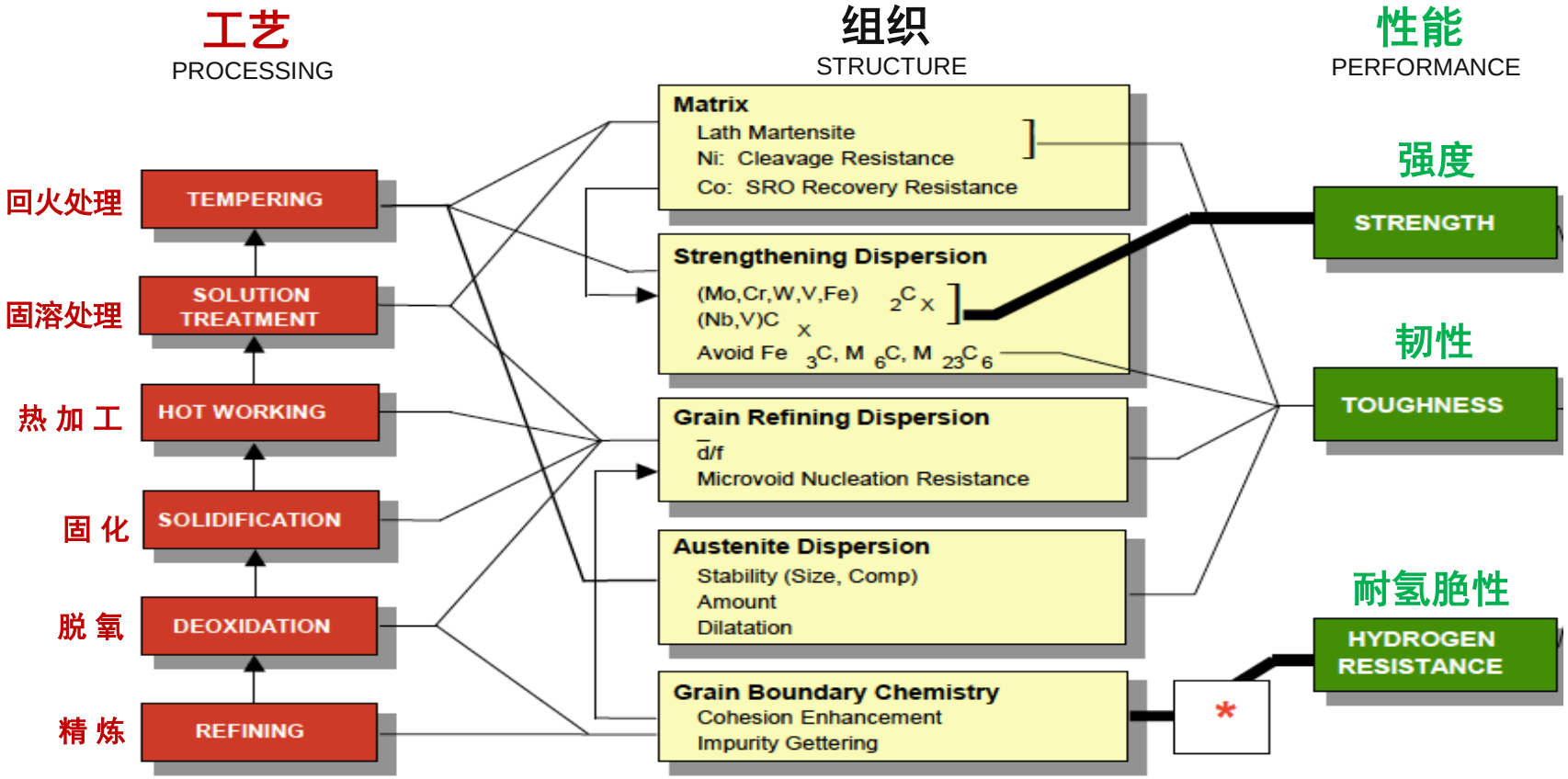


提高产品附加值，降低生产成本，增强企业竞争力

The steel banana - controversy between strength and formability. Helping steelmakers to regain competitiveness by selling higher margin products and by reducing manufacturing cost

钢厂根据产品性能要求选择工艺路线

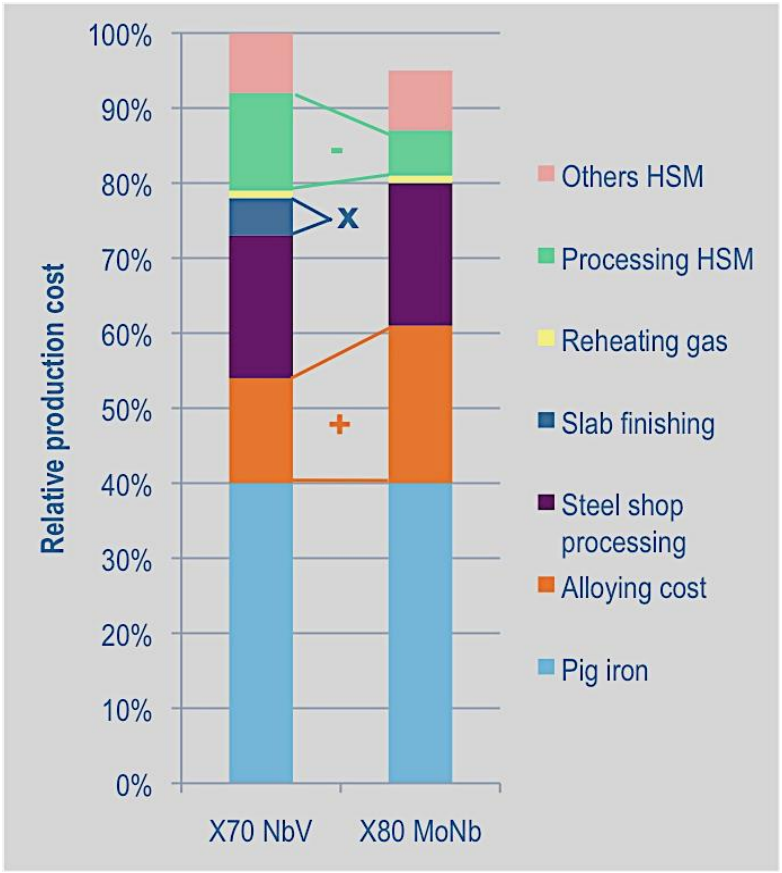
Steel producers **chose** how to achieve steel properties



为什么要开发合金钢？ Why alloy steel development?

- 因为它们都含有 0.1-0.2%的钼 Typically 0.1% to 0.2% Mo

1）先进结构钢 Advanced structural steels (AHSS)



成本效益分析—合金化 PK 工艺流程

Cost-benefit analysis – Alloying vs. Processing

节省的工艺成本超过合金总成本

Process savings with Mo alloy outweigh increases in overall alloying cost

- 有些钢厂已将 MoNb X70理念用于14mm以上的钢板。 MoNb X70 concept applied by Salzgitter, ArcelorMittal, Thyssen-Krupp and Hyundai Steel for gage >14 mm

在中国使用X70和X80的优势

Advantage applied in China to X70 and X80 product.

含Mo钢的优点 Mo strip product benefits:

- Lower total cost 总成本较低
- Higher strength (+70-100 MPa) 强度较高
- Enhanced toughness (+100 J) 韧性增强
- Better welding behaviour 焊接性能改善

尽管合金成本较高，但低碳MoNb钢为钢厂节约了工艺成本

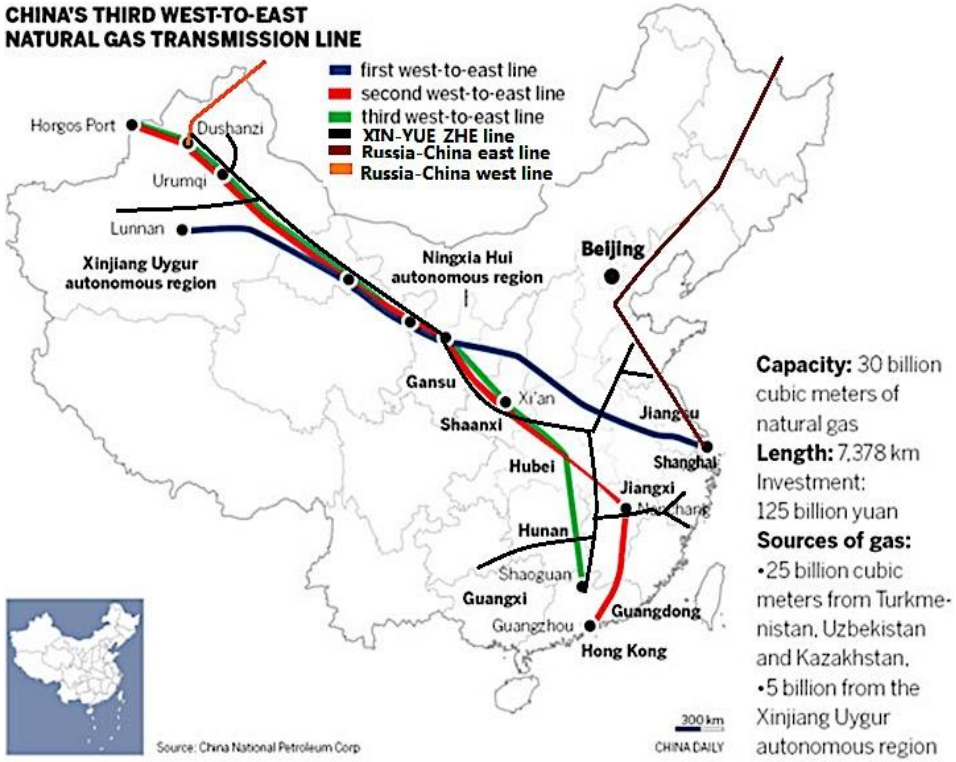
Low-carbon Mo Nb based alloy system reduces overall processing costs for steelmakers despite higher overall alloying costs.

与德国Salzgitter AG 公司合作完成全工艺成本分析

Full process cost analysis was performed in cooperation with Salzgitter AG / Germany.

1）先进结构钢 Advanced structural steels (AHSS)

中国重大管线项目 Major pipeline projects in China



Capacity: 30 billion cubic meters of natural gas
Length: 7,378 km
Investment: 125 billion yuan
Sources of gas:
•25 billion cubic meters from Turkmenistan, Uzbekistan and Kazakhstan.
•5 billion from the Xinjiang Uygur autonomous region

Original steel design was Mo-free (alloy cost saving)

原钢种不含钼（压缩合金成本）

- EU-HIPERC project showed that Moly alloying provides a generally more stable property spectrum.

EU-HIPERC项目证明含钼钢性能稳定

- Moly addition of 0.2-0.3% was specified and used in all strip products.

管线钢的钼含量为0. 2–0. 3%

- IMOA's SZMF project identified 0.1% Mo to be also beneficial for X80 heavy plate which was adapted by some suppliers as well.

国际钼协会SZMF项目证明0. 1%Mo就能改善X80钢板的性能，并被部分供应商采用。

西气东输2、3线工程已完工，各消费钼9000吨。未来还有多条输气管线

WEGP line 2 and line 3 are finished consuming 9,000 tons of Moly each. Further parallel lines to follow in the future.

1）先进结构钢 Advanced structural steels (AHSS)

山东莱芜钢厂研发成功 Achieved at Lai Wu Steel (Shandong province)

Element	C	Si	Mn	Nb	Ti	Mo	B	Cr/Ni/Cu
wt.%	0.06	0.16	2.0	0.05	0.013	0.22	0.0019	added

钼合金化+大功率轧机+MULPIC冷却 = 优质性能

Mo alloying + powerful plate mill + MULPIC (*) cooling = excellent properties

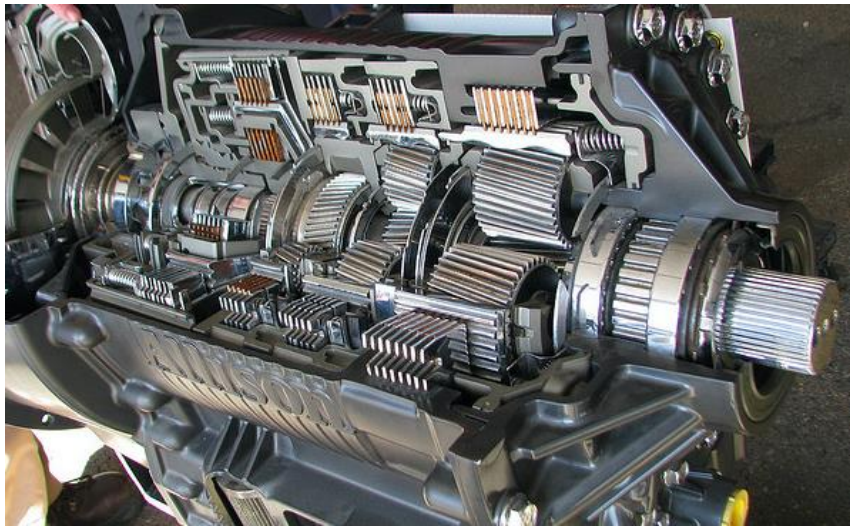
(*) multi-purpose interrupted cooling

Plate 钢板厚度： 25 mm
Yield strength 屈服强度： 900-965 MPa
Tensile strength 抗拉强度: 1040-1090 MPa
Elongation 延伸率: 15-16%
Transition temperature 相变温度: -60°C

太钢高强钢的钼消费量大约是500吨/年。
High strength steel production at TISCO generated Moly additional consumption amounts to around 500 tpy.

2) 工程钢和工具钢 Engineering and tool steels

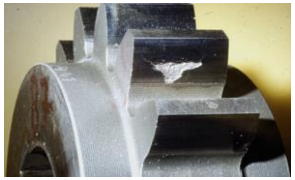
高性能齿轮钢
Gear steels with increased performance



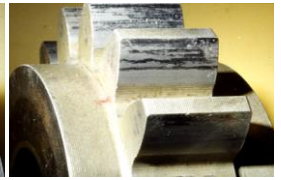
- 提高齿轮加工效率
  Improved efficiency of gear making process.
- 提高大型设备的可靠性
  Increased reliability in expensive capital equipment.

主齿失效形式 Main Gear Failure Modes

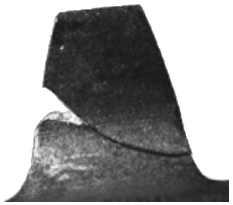
Pitting



Micro-pitting



Flank fracture



Root breakage

Shaanxi FAST Auto Drive Group Company is China's largest production enterprise for heavy-duty auto transmissions, auto gears, forgings and castings.

陕西法士特公司决定用新型材料V1（含钼0.54%）进行产品试制。按年产量20万吨计算，钼消费量为800吨/年

The FAST technical management decided to go for a project to test a 20MnCr5 mod. (Identified as Concept V1 – 0.54% Mo).

200.000 t/y 0.5 % Mo > 800 t/y

陕西法士特项目2018年7月23日在宝鸡启动

The FAST Project July 23d, 2018 Kick-off at Baoji (Shaanxi)

3) 铸铁 Cast iron

简单对比 A simple comparison...

- ✓ 16亿吨钢用掉70%的钼 1600 million tpy of steel consuming around 70% of Moly.
- ✓ 7千万吨铸铁用掉10%的钼 70 million tpy of cast iron consuming nearly 10% of Moly

钼在铸铁中的地位比在钢中更重要 Moly is more relevant in cast iron than in steel.

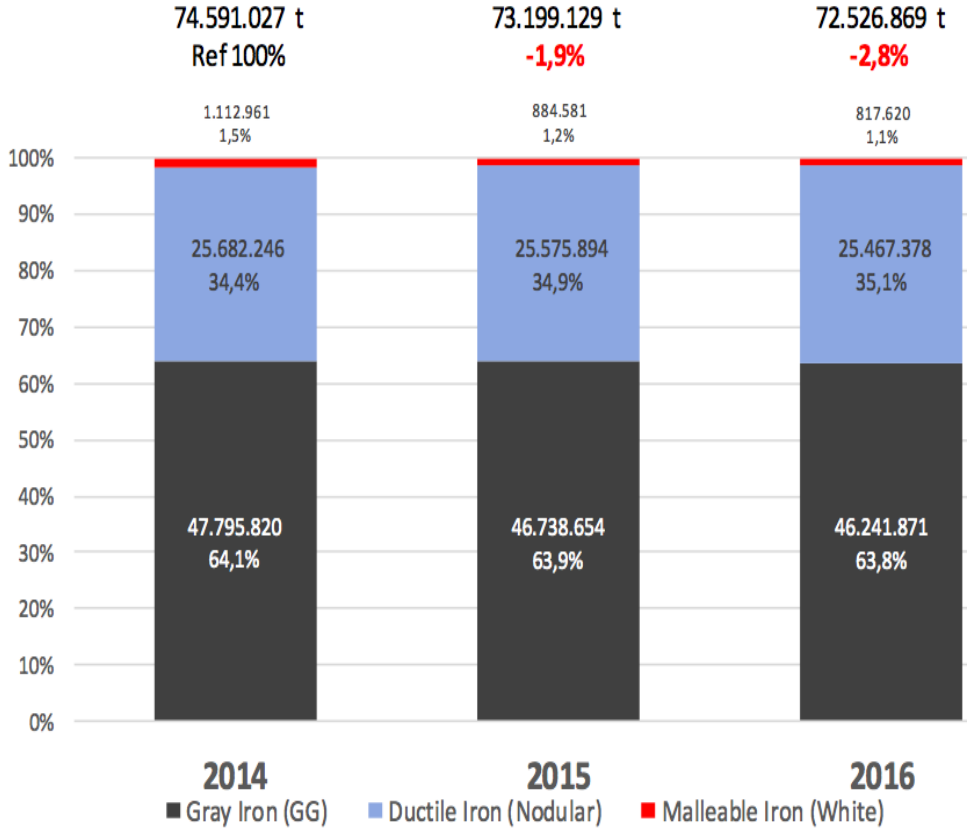
含钼铸铁的主产国：美国、德国、日本，中国是最大的铸铁生产国
Major producing countries for Moly alloyed irons are USA, Germany, Japan. ⇒ Like for steel, China is the biggest cast iron producing market by far.

中国含钼铸铁的增长潜力很大
Growth potential for Moly containing cast iron is high in China.

3) 铸铁 Cast iron

铸件是钼应用的一个重要领域

Castings (foundries) represent a significant market for Moly application



全球铸铁产量

Global cast iron production per type

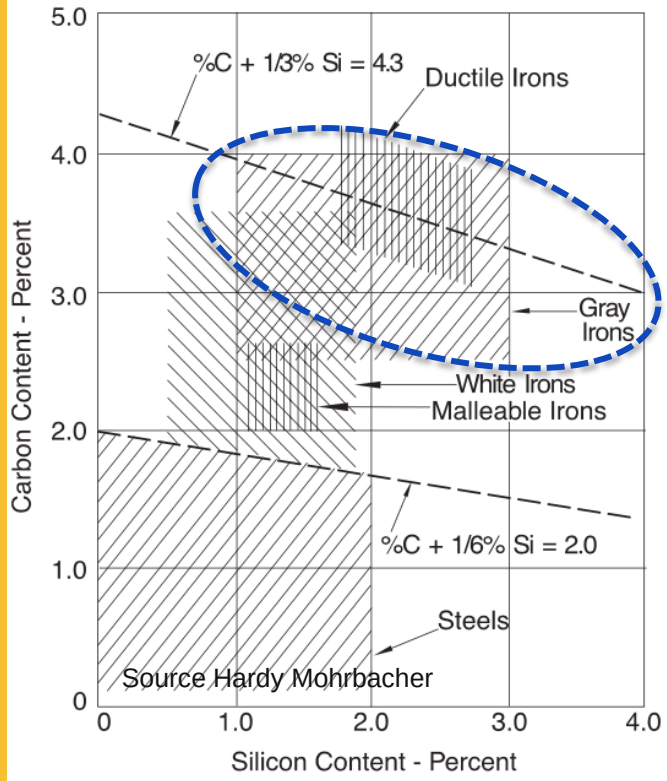
对铸造产品性能的要求逐步提高，特别是汽车行业（强度、韧性、导热性、耐磨性）

Increasing requests from the casting industry for better performance especially in automotive parts (strength, toughness, thermal conductivity, wear resistance)

Data compiled from Census of Worldwide cast production made by MODERN CASTING MAGAZINE in 2015; 2016 and 2017

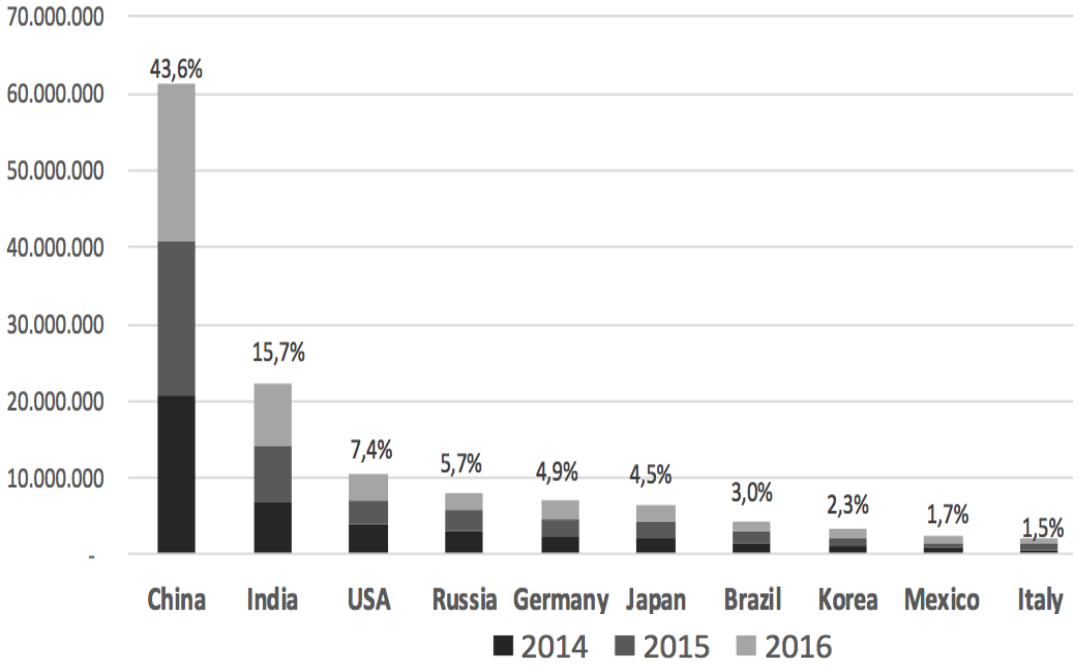
3) 铸铁 Cast iron

Types of cast iron



灰铸铁 产量，公吨

Gray iron production per country in metric tons



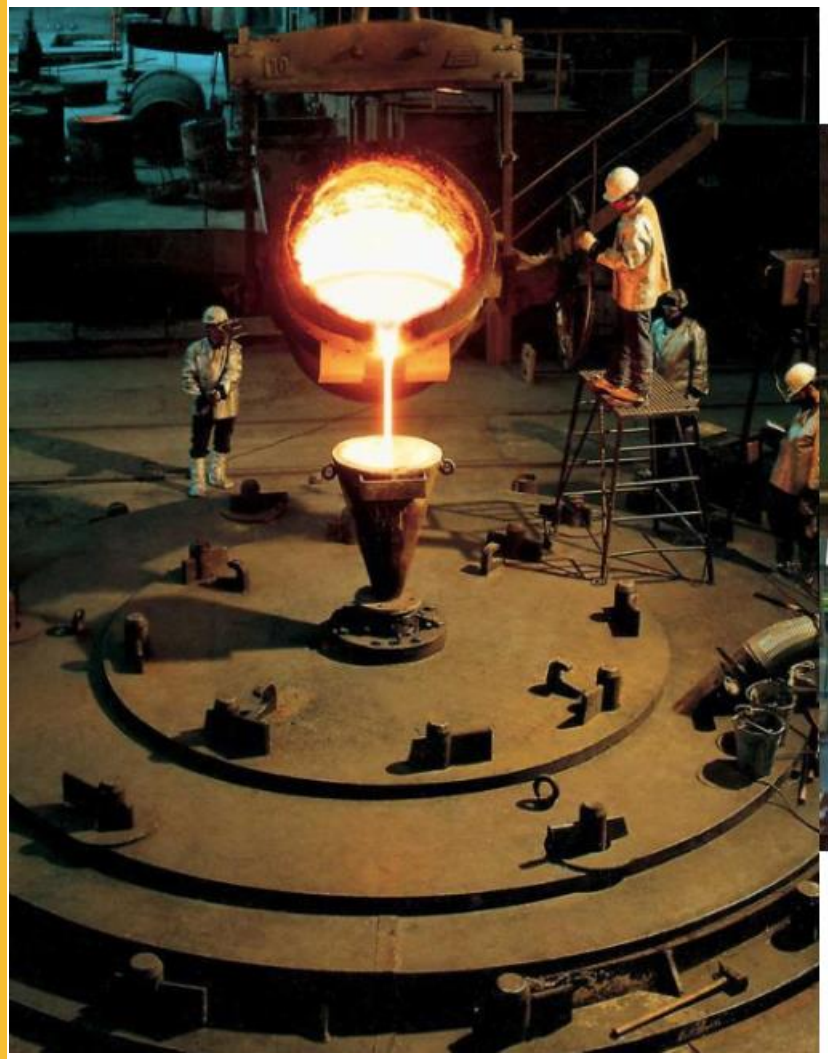
上海大学有中国铸造研发重点实验室，国际钼协会已经立项，支持钼合金灰铸铁研发

SHU is the key R&D lab in China for casting developments consequently IMOA started a project to support development of Moly alloyed grey cast iron

Data compiled from Census of Worldwide cast production made by MODERN CASTING MAGAZINE in 2015; 2016 and 2017

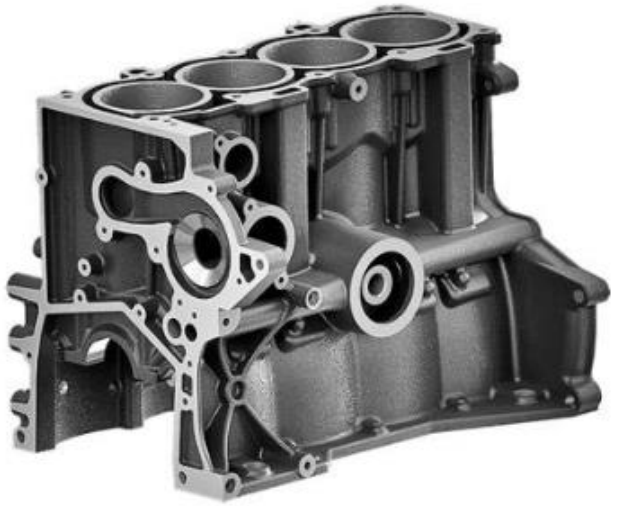
旋压铸造 ： 用于生产轧辊、圆柱等旋转对称部件

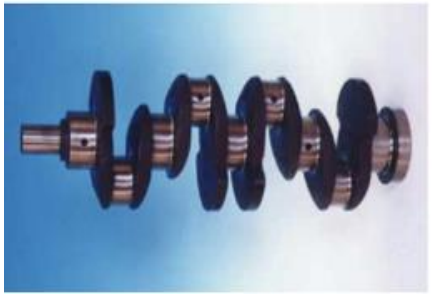
Spin casting for rotational symmetric components of rolls and cylinders



中小型灰铸铁产品

Grey Iron medium and small size applications

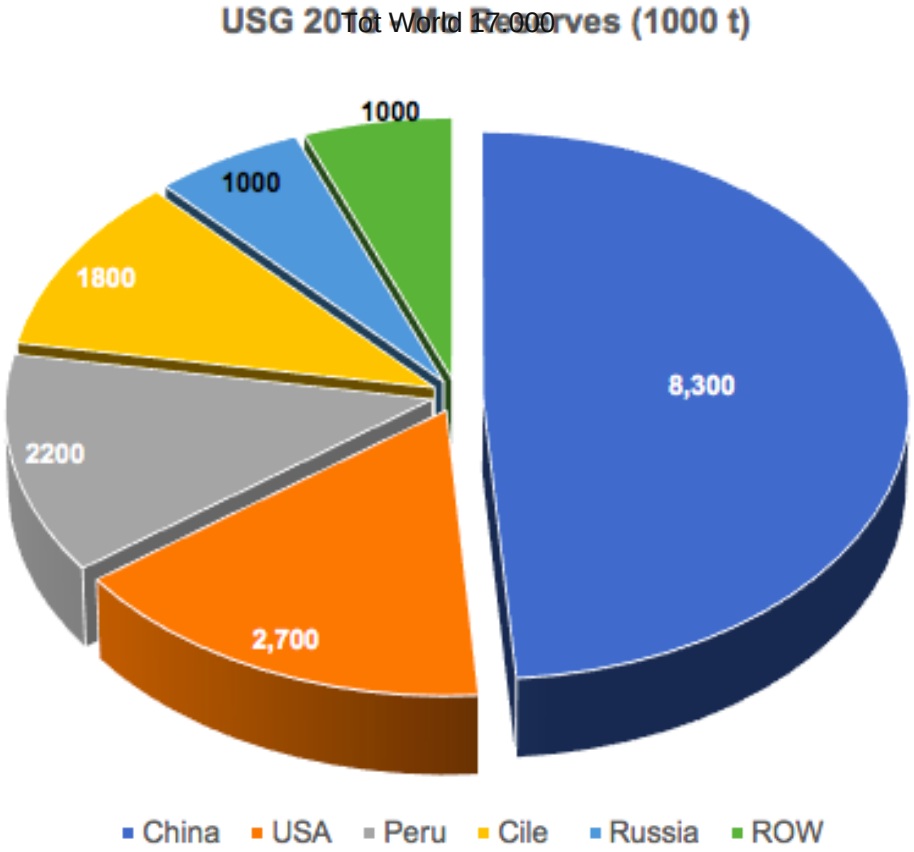




III. 路在何方？ What Next and Conclusions

中国：钼储量全球最大

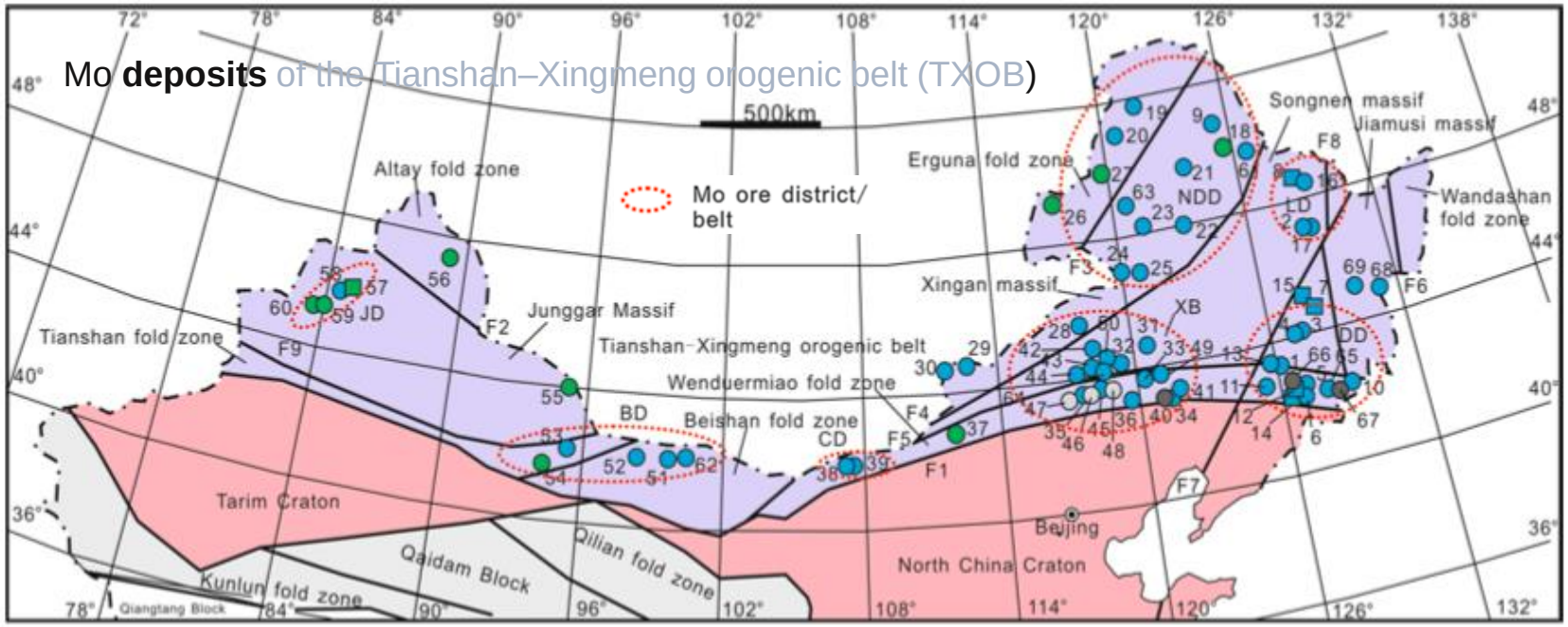
China: the largest Mo reserves in the world



储量是指已经探明且具备开采价值的矿产资源

Reserves may be considered a working inventory of an economically extractable mineral commodity (USG Definition)

III. 路在何方？ What Next and Conclusions



Ref	Deposit/ore spots	County (City)/Province	Deposit type	Commodity	Size	Mo Reserves/t	Mo Grade (%)
1	Daheishan	Yongji, Jilin	P	Mo	SL	1,090,000	0.07
2	Luming	Tieli, Heilongjiang	P	Mo	SL	890,000	0.08
3	Jidetun	Shulan, Jilin	P	Mo	L	430,000	0.09
6	Sanchazi	Dunhua, Jilin	P	Mo	L	325,000	0.07
9	Chalukou	Songling, Heilongjiang	P	Mo–Pb–Zn–Ag	SL	2,460,000	0.08
26	Wunuge-tushan	Manzhouli, Inner Mongolia	P	Cu–Mo	L	405,000	0.02
28	Diyanxinamu	Dongwuzhuqinqi, Inn. Mong.	P	Mo–Pb–Zn	L	400,000	0.1
53	Baishan	Hami, Xinjiang	P	Mo	L	396,000	0.03 -0.14

Ref: Porphyry molybdenum deposits in the Tianshan–Xingmeng orogenic belt, northern China **(2014)** Qingdong Zeng · Kezhang Qin · Jianming Liu · Guangming Li · Mingguo Zhai · Shaoxiong Chu · Yunpeng Guo

III. 路在何方？ What Next and Conclusions

中国的钼消费差距
The PRC's Moly Gap Question

	Moly 2017 (Tons)		Crude Steel 2017 (Million Tons)		Kg Mo / Ton Steel
Tot. W. Exc. China	189,6	69%	860	51%	0.22
China	84,4	31%	830	49%	0.10
Total	274,0	100%	1690	100%	0.16
Europe	57,6	21%	171	10%	0.34

Source SMR – End-use of Molybdenum; WORLD STEEL

钼在高端用钢中起着战略推动作用，但是，离开中国钼企业的支持，国际钼协会的专业知识就如同无弓之箭，毫无用武之地。

Moly is a strategic driver for High End Steels however IMOA's competence without the support of the Chinese moly industry it's like *an arrow without bow*

“2018 钼与钢高端论坛”部分议程

11月28日乐予新楼大学厅			
全　天	参会代表报到，办理入住手续		
18:30~	欢迎晚宴		
11月29日乐予新楼学海厅会议主（主持人：）			
时间	内容/报告题目	报告人	单位
08:30~09:00	开幕致辞	赵　沛 秘书长 Tim Outteridge	中国金属学会 金堆城钼业集团 国际钼协会 秘书长
09:00~09:30	大会主题报告	董　瀚 院长	上海大学材料学院
09:00~10:00	大会主题报告	Hardy Mohrbacher	比利时NiobelConbvba公司
10:00~10:20	茶　　歇		
先进碳钢的发展主题特邀报告（主持人：Hardy Mohrbacher 教授）			
10:20~10:45	特邀报告	Pello Uranga	西班牙CEIT公司
10:40~11:05	特邀报告	侯晓慧 教授	北京理工大学
11:05~11:30	特邀报告	王　利 首席研究员	宝武集团中央研究院
11:30~11:55	特邀报告	Takehide Semura教授	日本冈山大学
自助午餐 参观上海大学先进凝固技术中心			
特殊钢铸件的研发、生产及应用主题特邀报告（主持人：翟启杰教授）			
14:00~14:15	特邀报告		上海大学先进凝固技术中心
14:15~14:35	特邀报告		国内知名企业
14:35~14:55	特邀报告		国内知名企业
高性能工程用钢主题特邀报告（主持人：郭爱民教授）			
14:55~15:25	特邀报告	Frank Hippenstiel	德国BGH 优质钢有限公司
15:25~15:55	特邀报告	杨哲人 教授	台湾国立大学
15:55~16:25	特邀报告	黄　正 高工	中国汽车行业资深专家
16:25~16:55	特邀报告	Thiery Crémailh	德国斯塔 萨根柏钢铁集团
16:55~17:10	致闭幕辞	Nicole Kisnman	国际钼协会技术总监

2018钼与钢高端论坛

上海，2018年11月28-29日

主办单位：

中国金属学会

上海大学

国际钼协会

钼和含钼材料的世界

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